IRISH FISHERIES INVESTIGATIONS

SERIES A (Freshwater)

No. 12

(1973)

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J. J. BRACKEN

THE AGE AND GROWTH OF PIKE *Esox lucius* FROM FOUR IRISH TROUT RIVERS

The age and growth of pike *Esox lucius* from four Irish trout rivers

by

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ABSTRACT

Age and growth of pike *Esox lucius* L. taken by electrical fishing in four typical Irish trout rivers were determined, using isometric axis of scales. Age data showed that young pike dominated in catches in all four rivers. Very few pike older than four years were captured.

Growth of pike in these rivers was compared with earlier results obtained for lake pike. River pike were much smaller than fish of similar age from the larger limestone lakes.

Tag and recapture data from the Camlin river, confirmed that mean growth results were very similar to back-calculated means per year class. Data showed little movement of pike within this system and that electrical fishing was reasonably efficient for clearance of coarse fish in shallow trout waters. Stomach contents of pike taken in Robe and Camlin rivers were qualitatively analysed.

Since 1952 the Inland Fisheries Trust's development programme has included the removal of pike and other coarse fishes from a number of Irish trout lakes and rivers. Pike control methods in large lakes include the use of:—

(i) Gill-nets, which catch adult pike and potential recruits;

(ii) Wire perch traps, which catch mainly O-group pike and

(iii) Spot-treatment of pike spawning and nursery areas to kill small pike fry.

In rivers electrical fishing is used to remove unwanted coarse fish. Electrical A/C generators with an output of 220/250 volts are used from boats. One, two or more boats are used according to the width of the river. Stop-nets are also sometimes employed.

An investigation of the age and growth of pike in a number of Irish lakes, based on material collected as described above, has previously been carried out (Bracken and Champ, 1971). The present paper gives the results of analysis of material from four Irish rivers.

The rivers surveyed were :— the River Robe, County Mayo; the Camlin river, County Longford, the Brosna river, County Offaly and the Little Brosna, Counties Offaly and Tipperary, (See Fig. 1). Apart from the Robe, all these rivers are tributaries of the Shannon.

TOPOGRAPHY

The Robe rises above Brickens in South Mayo and drains into Lough Mask. The height above sea level at its source is 300 feet, decreasing to 100 feet at the entrance to Lough Mask. The river is 53 kilometres in length and flows over limestone bed-rock. Brown trout occur. The average pH is 7.9.

The Little Brosna is 48 kilometres in length and has but one major tributary, the Camcor. It rises near Dunberrin in Co. Offaly at an elevation of some 350 feet. At its point of entry into the River Shannon it lies at about 100 feet above sea level and flows over limestone. Both salmon and trout occur. The pH range is 7.8 to 8.2.

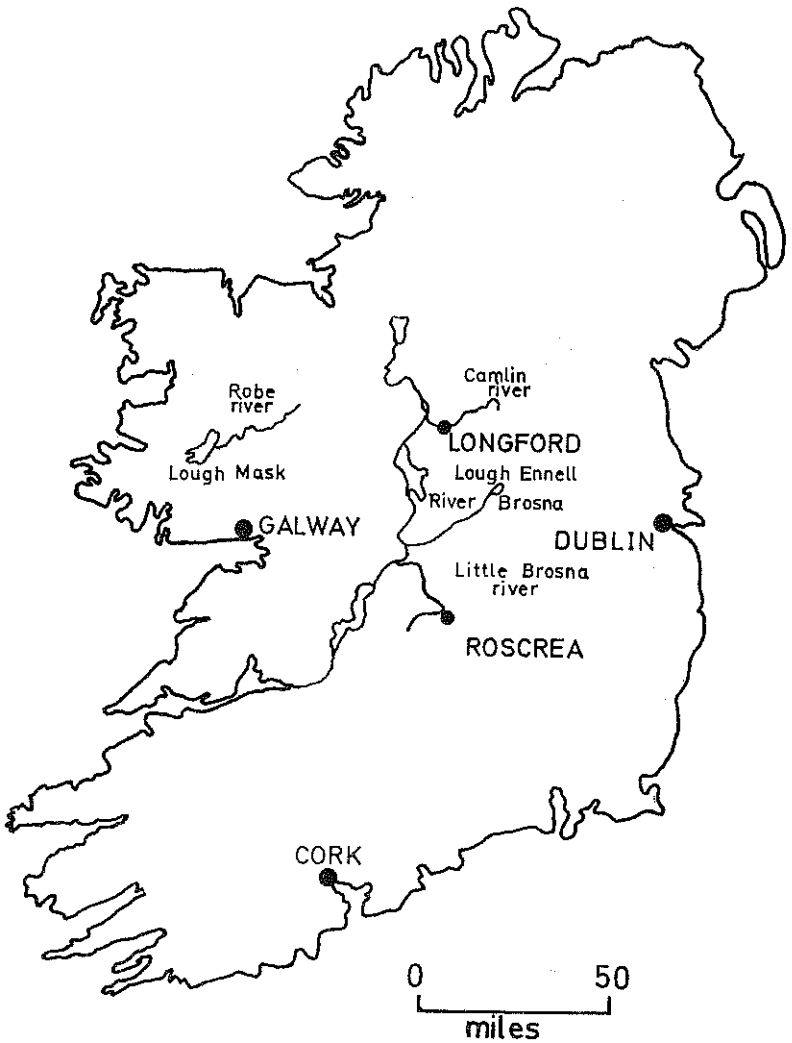

Fig. 1. Sketch map of Ireland showing locations of the rivers investigated. (Based on the Ordnance Survey by permission of the Government, Permit No. 1833).

The River Brosna is 62 kilometres in length and takes origin as an outlet from Lough Ennell (elevation 268 feet). It flows into the River Shannon at Shannon Harbour. It is a limestone river. The pH range is 7.9 to 8.3.

The Camlin river, 37 kilometres in length, rises near the town of Granard in County Longford. It also lies on limestone with an average pH value of 8.0. The river bifurcates about three miles below the town of Longford and opens into the Shannon one mile further down river.

All four rivers are dry-fly trout streams rather than typical coarse fish rivers i.e. they are not very wide; mainly shallow, except where there are pools; fast flowing and well oxygenated (except for the lower portion of the Camlin, which is subject to pollution).

MATERIALS AND METHODS

The material examined comprised (a) sets of scales from sexed and measured pike, aged one year and upwards from the four rivers and (b) recorded stomach contents of pike weighing 1 lb. (454g) and upwards from two of the rivers (Rivers Robe and Camlin). The fish were measured from the tip of the snout to the fork of the tail-fin. The scales were used subsequently to determine age and growth. The scales examined had well defined annuli with "chaining" present on the first annulus as described by Williams (1960). In this regard they conformed to the pattern previously observed in pike scales from Irish limestone lakes (Bracken and Champ, 1971). Growth was estimated by measuring the spacing of the annuli along the short or isometric axis of the scales, which permits direct back-calculations to be made. A tagging programme subsequently carried out by the Trust in the Camlin system provided data to corroborate the deductions made from the pike scales.

Most of the material was collected in June and July each year so that "plus-growth" was present on the scales. In estimating the length-for-age data this was disregarded, the calculations being based on the size at formation of successive annuli.

Only the one, two and three-year-old fish were treated statistically and then only when ten or more fish were present. The length-for-age data were punched on eighty column computer cards on which were also recorded age, weight, sex and year class. Mean lengths at capture, mean weights at capture, mean back-calculated lengths at each age and standard deviations per sex were then calculated.

Qualitative stomach contents were recorded for some River Robe and Camlin pike.

RESULTS

The Robe River

The Robe pike data are shown as percentage frequency histograms, irrespective of sex (Fig. 2). Ages ranged from 1 to 8 years. Two-year-olds dominated in each of the three years, followed by the one- and three-year-olds, respectively. The numbers of four-year-olds taken were always small. Older fish were scarce and were not considered further. The computer data are summarised in Table 1. The percentage of the one-, two- and three-year-olds, irrespective of sex, in the overall catches was 83.6% (179 fish) in 1967, 86.5% (290 fish) in 1968 and 86% (267 fish) in 1969.

The 1966 year class (one-year-olds in 1967) may be followed through the 1968 and 1969 age distributions as two- and three-year-olds. The 1965 year class (two-year-olds in 1967) may be seen as three-year-olds in the 1968 distributions. Finally, the 1967 year class (one-year-olds in 1968) appears as two-year-olds in the 1969 data. The data exhibits Lee's phenomenon (Lee, 1920). If the means of the lengths at capture of the 1966 year class (one-year-olds in 1967) for both male and female fish are followed as two-year-olds in 1968 and three-year-olds in 1969, (Table 1), the back-calculated lengths decrease as the fish increase in age. This is also true for the 1965 year class (two-year-olds in 1967) when compared with the three-year-olds in 1968. A decrease in L_1 values occurs for male and female fish. Back-calculated L_1 means for the 1967 year class (two-year-olds in 1969) show exactly the same pattern when compared with the one-year-olds in the 1968 distributions. The probable explanation of this phenomenon is the tendency for the faster-growing pike to be captured as young fish and the slow-growing pike to escape capture for several seasons.

The Little Brosna River

Scales were only available for the years 1967 and 1969. The 1967 and 1969 percentage frequency distributions are shown (Fig. 3). The two- and three-year-olds predominated and together constituted 78.5% (1967) and 70.0% (1969) of the total age distributions. The computer data for these fish are summarised in Table 2. Results for the 1967 fish indicated that the mean lengths and mean back-calculated length for males and females were similar but the weight of the females was generally greater. The numbers of male fish in 1969 were too low to be significant. In the case of the three-year-old fish males and females were similar but the male fish were heavier.

The River Brosna

As in the case of the Little Brosna data were only available for the 1967 and 1969 periods. The number of fish taken during these two periods indicates that the pike population is greater here. The percentage frequency distributions show that, as in the Little Brosna, the two- and three-year classes made up 89% of the total in 1967 and 59% in 1969. In 1969, a fairly large influx (36%) of one-year-olds was evident but the two-year-olds were still dominant while the three-year-olds showed a marked drop (Fig. 4). Although the females were heavier in 1967 the length data were similar for both sexes (Table 3). The mean lengths for the one-year-olds is also seen. The same pattern is apparent in the two-year-olds but the L_2 value is larger for the females and their weight heavier. The three-year-old males were not considered because of low numbers.

Table 1. Length, weight and back-calculated lengths per sex of pike in the Robe river for 1967, 1968 and 1969.

Males										Females								
Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.	Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.
1967																			
1	47	Min.	17.8									Min.	13.5						
		Mean	22.1	3.0					273	1	13	Mean	21.3	3.4					236
		Max.	35.6									Max.	26.7						
		Min.	11.4		24.1							Min.	12.7		27.3				
2	44	Mean	20.4	5.7	36.6	6.6			670	2	24	Mean	18.9	4.3	37.7	6.1			728
		Max.	36.8		57.2							Max.	27.9		52.3				
		Min.	12.7		25.4		34.3					Min.	14.6		27.9		36.8		
3	21	Mean	19.7	3.7	34.6	5.7	44.4	6.6	956	3	30	Mean	20.0	3.9	38.5	5.0	49.3	5.5	1,516
		Max.	27.9		45.7		58.4					Max.	30.5		49.5		58.4		
1968																			
1	59	Min.	10.2																
		Mean	17.8	3.4					267	1		Numbers too Low							
		Max.	25.4																
		Min.	12.7		24.1							Min.	12.7		25.4				
2	94	Mean	18.2	3.1	33.9	5.0			523	2	86	Mean	19.3	3.6	35.5	4.9			594
		Max.	26.2		44.7							Max.	27.9		47.0				
		Min.	14.7		32.0		40.6					Min.	10.2		21.3		42.7		
3	11	Mean	18.8	2.3	36.5	2.2	46.8	4.6	1,041	3	34	Mean	19.9	3.6	39.7	5.4	51.5	6.4	1,544
		Max.	22.9		39.4		55.9					Max.	28.4		48.3		60.5		
1969																			
1	67	Min.	18.8																
		Mean	21.8	2.4					190	1		Numbers too Low							
		Max.	28.4																
		Min.	12.2		22.4							Min.	11.4		26.2				
2	80	Mean	16.7	3.1	33.2	5.3			437	2	52	Mean	17.1	2.8	35.0	4.1			525
		Max.	23.9		41.1							Max.	21.1		49.3				
		Min.	14.0		28.4		33.0					Min.	10.2		18.8		26.2		
3	31	Mean	17.6	2.1	33.2	3.2	43.1	4.2	856	3	34	Mean	18.4	3.9	33.8	5.2	46.4	6.8	1,137
		Max.	20.8		38.1		55.1					Max.	22.9		39.1		58.4		

Table 2. Length and weight distribution per sex for the Little Brosna 1967 and 1969.

Males										Females								
Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.	Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.
1967																			
2	32	Min.	11.4		30.5							Min.	10.2		23.8				
		Mean	19.6	3.6	38.4	4.8			551	2	35	Mean	19.1	4.6	42.5	1.1			617
		Max.	25.4		47.0							Max.	26.2		74.7				
		Min.	10.2		26.9		41.9					Min.	10.7		25.4		43.2		
3	19	Mean	19.7	4.9	37.0	5.0	48.2	3.9	1,094	3	20	Mean	18.2	5.6	37.8	6.5	51.3	5.6	1,379
		Max.	29.5		47.8		55.9					Max.	25.9		49.3		62.2		
1969																			
2		Numbers too Low								2	12	Min.	12.7		22.9				
												Mean	23.2	8.2	41.7	1.2			1,355
												Max.	34.3		59.7				
		Min.	12.7		25.4		32.0					Min.	12.7		21.6		28.2		
3	13	Mean	21.0	5.6	40.2	6.8	51.0	7.2	1,401	3	28	Mean	21.1	4.4	36.6	6.6	48.7	8.8	1,289
		Max.	33.0		50.8		62.2					Max.	34.3		47.2		61.0		

Table 3. Length and weight distribution per sex for the Brosna river 1967 and 1969.

Males										Females								
Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.	Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.
1967																			
		Min.	10.2		19.1							Min.	10.2		21.1				
2	97	Mean	15.6	3.3	28.7	4.6			225	2	66	Mean	16.5	4.3	31.3	6.3			294
		Max.	28.4		41.9							Max.	27.9		43.2				
		Min.	11.4		22.9		30.5					Min.	11.4		23.4		29.2		
3	35	Mean	19.6	4.6	33.8	4.9	41.8	5.9	586	3	54	Mean	18.0	3.9	33.3	5.6	42.3	6.2	724
		Max.	27.9		43.2		53.3					Max.	27.9		47.0		55.9		
1969																			
		Min.	11.4									Min.	12.7						
1	63	Mean	21.6	4.3					361	1	41	Mean	22.5	4.0					432
		Max.	35.6									Max.	32.0						
		Min.	10.2		21.8							Min.	11.4		24.1				
2	79	Mean	15.4	3.0	32.8	7.3			585	2	64	Mean	17.0	4.3	36.1	6.6			770
		Max.	22.9		52.3							Max.	31.8		49.5				
												Min.	10.2		17.8		25.4		
3		Numbers too Low								3	23	Mean	15.2	3.4	30.5	7.0	47.4	10.6	1,456
												Max.	23.6		46.5		67.6		

Table 4. Length, weight and back-calculated lengths per sex for three zones in the Camlin river 1969.

Location	Males										Females									
	Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D.	Total Length at Capture	S.D.	Mean Weight g.	Age	Nos. of Fish	Length cm.	L_1	S.D.	L_2	S.D	Total Length at Capture	S.D.	Mean Weight g.
Zone A			Min.	10.2									Min.	12.7						
Cloonfin	1	25	Mean	14.6	2.2					154	1	19	Mean	14.8	2.3					184
Lake/			Max.	19.1									Max.	19.1						
Ballinalee			Min.	11.2		22.9							Min.	13.0						
	2	26	Mean	15.5	2.4	28.6	2.9			213	2	19	Mean	15.7	2.2	29.1	2.6			221
			Max.	20.8		33.0							Max.	21.6						
			Min.	14.0		25.9		34.3					Min.	13.5		24.2		32.4		
	3	27	Mean	17.0	2.5	30.5	3.1	39.7	4.0	567	3	11	Mean	17.2	3.1	30.0	4.6	41.2	6.4	639
			Max.	22.9		35.6		49.5					Max.	22.9		35.6		43.8		
Zone B			Min.	10.2									Min.	10.2						
Ballinalee/	1	116	Mean	14.6	2.2					197	1	96	Mean	14.5	2.2					226
Carriglass			Max.	25.4									Max.	22.9						
			Min.	10.9		23.9							Min.	12.7		26.7				
	2	54	Mean	16.0	2.5	31.3	4.0			289	2	34	Mean	17.3	2.8	34.2	4.2			498
			Max.	21.6		40.6							Max.	21.6		41.9				
			Min.	11.7		24.4		33.8					Min.	12.7		23.4		30.5		
	3	40	Mean	16.4	3.3	31.8	4.4	42.8	4.5	628	3	24	Mean	16.9	2.9	32.1	4.7	44.4	6.4	817
			Max.	24.6		40.6		52.6					Max.	21.6		41.1		55.9		
Zone C			Min.	10.9									Min.	10.2						
Carriglass/	1	67	Mean	16.6	3.5					228	1	91	Mean	15.9	2.9					208
Longford			Max.	26.1									Max.	25.4						
			Min.	11.4		24.1							Min.	13.2		30.5				
	2	18	Mean	15.6	2.3	32.5	3.8			403	2	14	Mean	16.1	2.6	23.9	2.9			393
			Max.	18.3		40.6							Max.	21.1		40.0				
	3		Numbers too Low								3		Numbers too Low							

The Camlin River

Pike reduction was begun in this river in 1969 and was limited to the stretches from Cloonfin Lake down to Longford town. Below the town the river is heavily polluted (Kennedy-pers. comm.). The stretch of river electrically fished was divided into three zones, viz.:

(a) Cloonfin Lake to Ballinalee.

(b) Ballinalee to Carriglass.

(c) Carriglass to Longford.

A total of 765 pike was captured in these three zones during the summer and autumn of 1969. The computer data are summarised in Table 4. The percentage age distributions, irrespective of sex, are given for each region (Fig. 5). The one- and two-year-old fish were dominant. The highest percentage frequency (77.5%) was found to occur in the one year-olds taken in Zone C. These fish showed an appreciably lower percentage in the other two regions of the river. This does not suggest a significant down-river movement as the fish grew older, nor does it support local opinion that there was an appreciable influx into the river of pike from Cloonfin Lake. To obtain direct information of this, in February, 1970, pike were tagged with Floy tags in four lakes at the head of the Camlin system including Cloonfin Lake (*Ann. Rep. Inland Fisheries Trust,* 1971). In all 50 pike were tagged although only two of these, both large, were from Cloonfin Lake. In April, 1970, 42 pike were tagged in the Camlin itself, between Cloonfin Lake and Longford. The river was electrically fished on four occasions between August, 1970 and April, 1971. One tagged pike was taken by an angler in Killeen Lake on February 7th, 1971. All other recaptures were made by the electrical fishing. No lake pike were taken in the river, but 22 pike marked in the river were recaptured. All the recaptures were taken in close proximity to the original release areas. All the fish were in good condition. The growth made by them during the release period corresponds with the estimated annual growth increment of pike in the river as calculated from the scales of the pike sampled in 1969.

Stomach Analyses

The stomach contents of the Robe river pike (one-, two- and three-year-olds), weighing 1 lb. (454g.) or over, were examined as follows:—

	Numbers of Stomachs	*Numbers with Food*
1967	149	69
1968	202	167
1969	167	72

Since the pike were captured in late June/early July for a restricted period any conclusions must be tentative. It would appear, that the Robe pike show preference for crayfish (*Potamobius pallipes*) and brown trout in that order (Table 5).

Table 5. Percentage frequency distributions per year of food contents for River Robe pike.

	1967	*1968*	*1969*
Potamobius pallipes	53.6	76.7	56.9
Salmo trutta	26.0	13.2	33.3
Gasterosteus aculeatus	4.4	7.2	1.4
Esox lucius	5.8	1.8	4.2
Gobio gobio	1.5	—	—
Phoxinus phoxinus	—	—	1.4
Anguilla anguilla	2.9	—	—
Anas platyrhynchus	2.9	—	1.4
Rattus norvegicus	2.9	1.1	1.4

J. J. Bracken: Age and growth of pike.

In the Camlin river stomachs of the one-, two- and three-year-olds were examined:

1969	*Age*	*Number of stomachs with food*
	1	117
	2	49
	3	34

There is, in this case, a little more information about the food preference shown by the different age groups. (Table 6).

Table 6. Percentage distribution of food in the Camlin pike stomachs for the one-, two- and three-year-olds.

	1 Year Olds	*2 Year Olds*	*3 Year Olds*
Potamobius pallipes	41.9	7.9	3.3
Gammarus sp.	—	1.4	—
Unidentified insect remains	—	29.5	20.0
Salmo trutta	22.2	14.0	10.0
Gobio gobio	11.1	8.4	—
Gasterosteus aculeatus	8.5	2.8	—
Perca fluviatilis	6.9	—	6.7
Perch ova	—	—	6.7
Anguilla anguilla	1.8	3.9	10.0
Esox lucius	1.8	—	3.3
Nemacheilus barbatula	0.8	3.9	—
Unidentified fish remains	2.5	25.2	10.0
Rana temporaria (Ova)	2.5	3.0	30.0

DISCUSSION

By Irish standards the four rivers surveyed are typical trout waters because of their size, depth and the presence of a limited number of pools. Large pike do not occur in rivers of this type, and this view is supported by the fact that only a small number of four-year-old and older fish were taken in the catches. It is felt that large pike do not escape capture in such waters because they are more easily seen than the smaller fish, particularly when weed-beds are present.

The pike data collected in these trout waters cannot be considered as representative of or applicable to larger, deeper Irish river systems. No such system has been investigated to date in this country.

Unfortunately, mortality estimations could not be carried out because of the sporadic nature of the clearance work but the age and growth of pike were calculated. From the available information an attempt is now made to compare age and growth in lake and river pike. Healy (1954) has shown that growth differences in pike occur in Irish lakes. Bracken and Champ (1971) have demonstrated that growth may be divided into fast, average and slow in Western, Midland and small lakes (irrespective of location), respectively. The growth of the one-, two- and three-year-olds in the three lake categories is shown in Table 7.

Table 7. Mean growth (in cm) of one-, two- and three-year-old pike per sex in three categories of Irish Lakes.

	Males			Females		
	L_1	L_2	L_3	L_1	L_2	L_3
Western Lakes	25	44	58	23	45	59
Midland Lakes	23	37	44	23	39	48
Small Lakes	13	35	—	16	37	—

When these growth patterns are compared with those of the river pike the following observations may be made:—

(i) The growth in any of the four rivers is not comparable with the fast growth category found in pike of the Western lakes;

(ii) The growth of pike from the Rivers Robe and Little Brosna is similar to that found for pike in Midland lakes;

(iii) The growth of pike from the Brosna river is intermediate between the average and slow growth categories of lake fish and

(iv) Growth of pike in the Camlin river is slow.

One final observation is that growth of pike from the Robe and Little Brosna is greater than that from the other two rivers.

It has already been shown that pike from the River Robe appear to demonstrate Lee's phenomenon (Table 1) i.e. back-calculations from the scales of the older pike sampled give mean L_1 and/or L_2 values smaller than the actual lengths at capture of fish of the year-classes in question sampled in earlier seasons. This is probably due to unavoidable selectivity in electro-fishing where the smaller pike are concerned. The smaller the pike the less the voltage drop to which it is subjected for any given voltage gradient produced in the river by the apparatus. At a certain distance from the electrodes, therefore, smaller pike tend to be only stimulated where larger pike are stunned. Moreover, small pike, if stunned, are more likely to escape detection and recover if they sink into weeds. The tendency is, in consequence, for the faster growing young pike of any given year class to be captured a season earlier than the slower-growing fish during annual clearance operations.

The recapture rate of pike from the Camlin river has been high (22 fish out of a possible 42, mainly one- and two-year-olds). There is little doubt that in rivers similar to those investigated electrical fishing can effect a substantial reduction in the numbers of pike present, even with the smaller pike. The numbers of recaptured pike are considered to be extremely high particularly in view of the fact that these figures make no allowance for natural mortality, tagging mortality or tag shedding.

SUMMARY

1. The age and growth of pike, taken by electrical fishing, in four typical Irish trout rivers were examined. Where possible qualitative analyses of stomach contents were also carried out (Robe and Camlin rivers).

2. Three of the rivers, the Big Brosna (1,092 pike taken), the Little Brosna (253 pike taken) and the Camlin river (765 pike taken), are tributaries of the Shannon. The Robe river (859 pike taken) drains into Lough Mask.

3. The age data show that two-year-old pike dominate in three rivers (Little Brosna, Big Brosna and Robe) while the one-year-olds dominate in the Camlin River. Three-year-old pike are also abundant in all four rivers. Four-year and older fish were scarce throughout.

4. Growth of pike in these rivers has been compared with growth of lake pike. Pike growth in the Robe and Little Brosna is similar to that of the Midland lakes. The pike in the Big Brosna show intermediate growth patterns between fish in the Midland and small lakes. Pike growth is poor in the River Camlin but compares favourably with the growth in small lakes.

5. Tag and recapture data for the River Camlin shows that there is little movement of the pike within the system. The scales of the recaptured pike exhibit mean growth results, which are very similar to the back-calculated means per year class.

6. Lee's phenomenon, as exhibited by the River Robe pike (Table 1), is thought to be due to the greater likelihood of slow-growing pike evading early capture (Table 1).

7. Since 52% of the tagged Camlin pike were recaptured by electrical fishing this method of pike removal is considered to be efficient in shallow trout waters.

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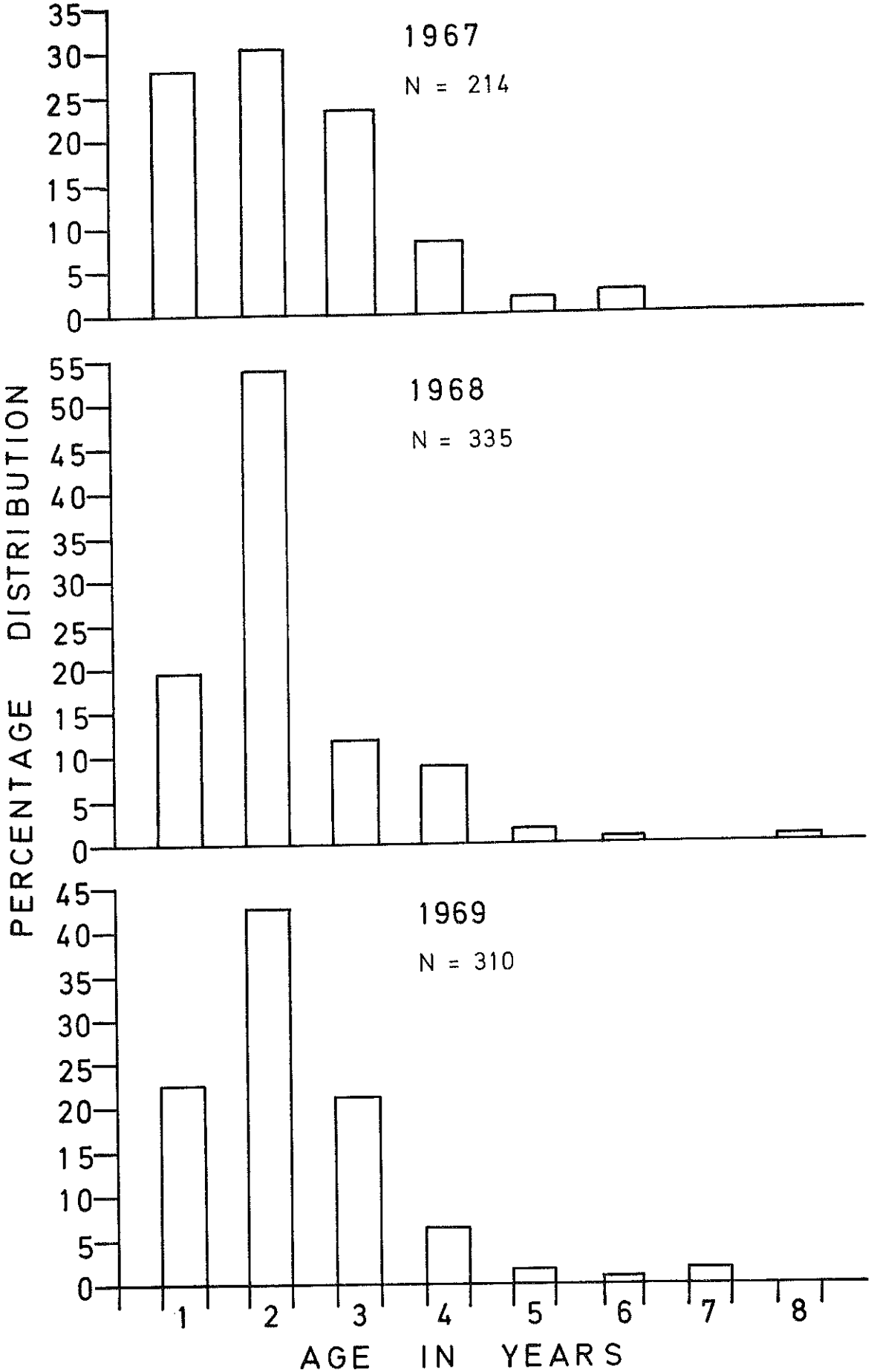

Fig. 2. Percentage age distributions for the Robe river pike during 1967, 1968 and 1969.

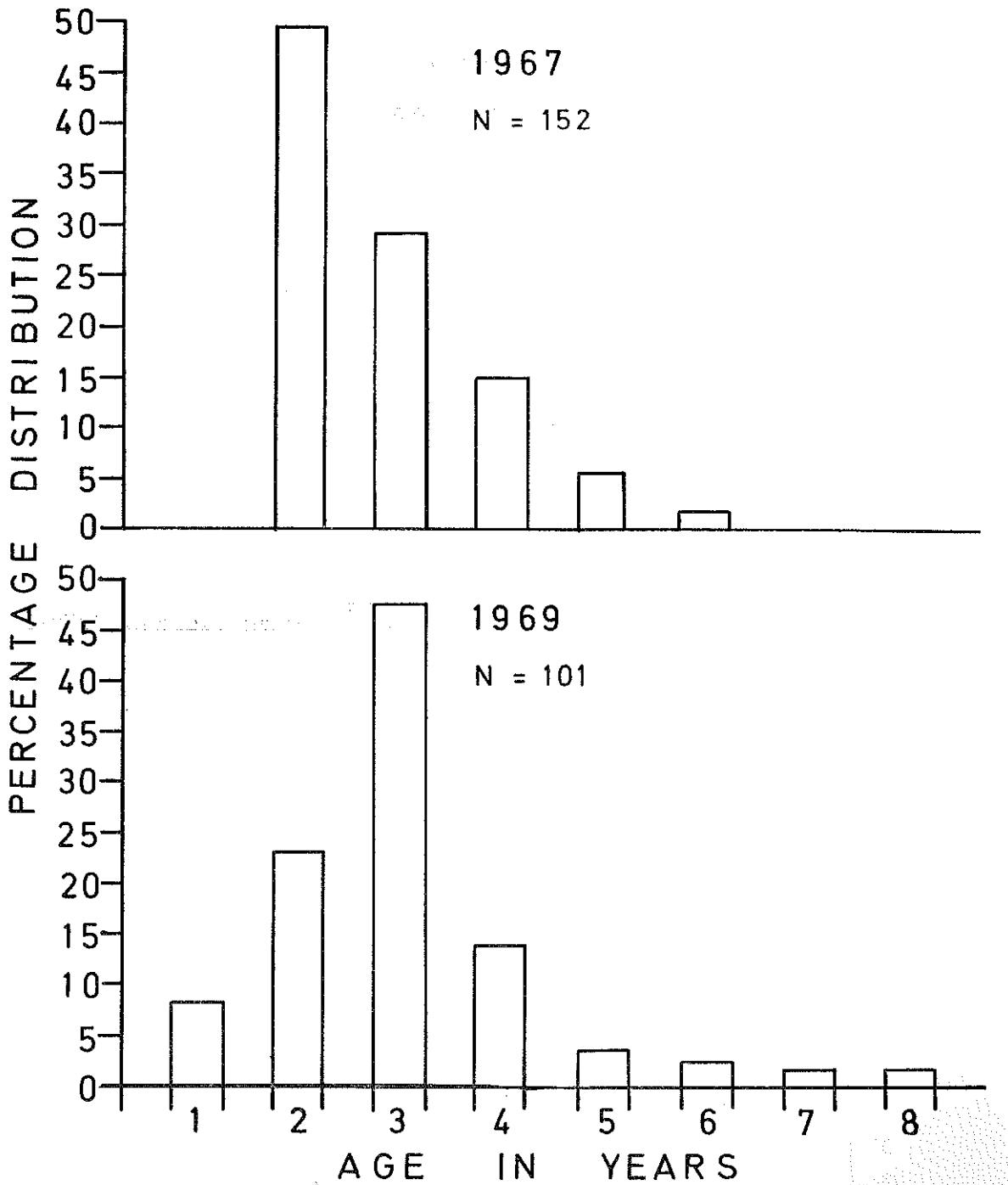

Fig. 3. Percentage age distribution for pike from the Little Brosna during 1967 and 1969.

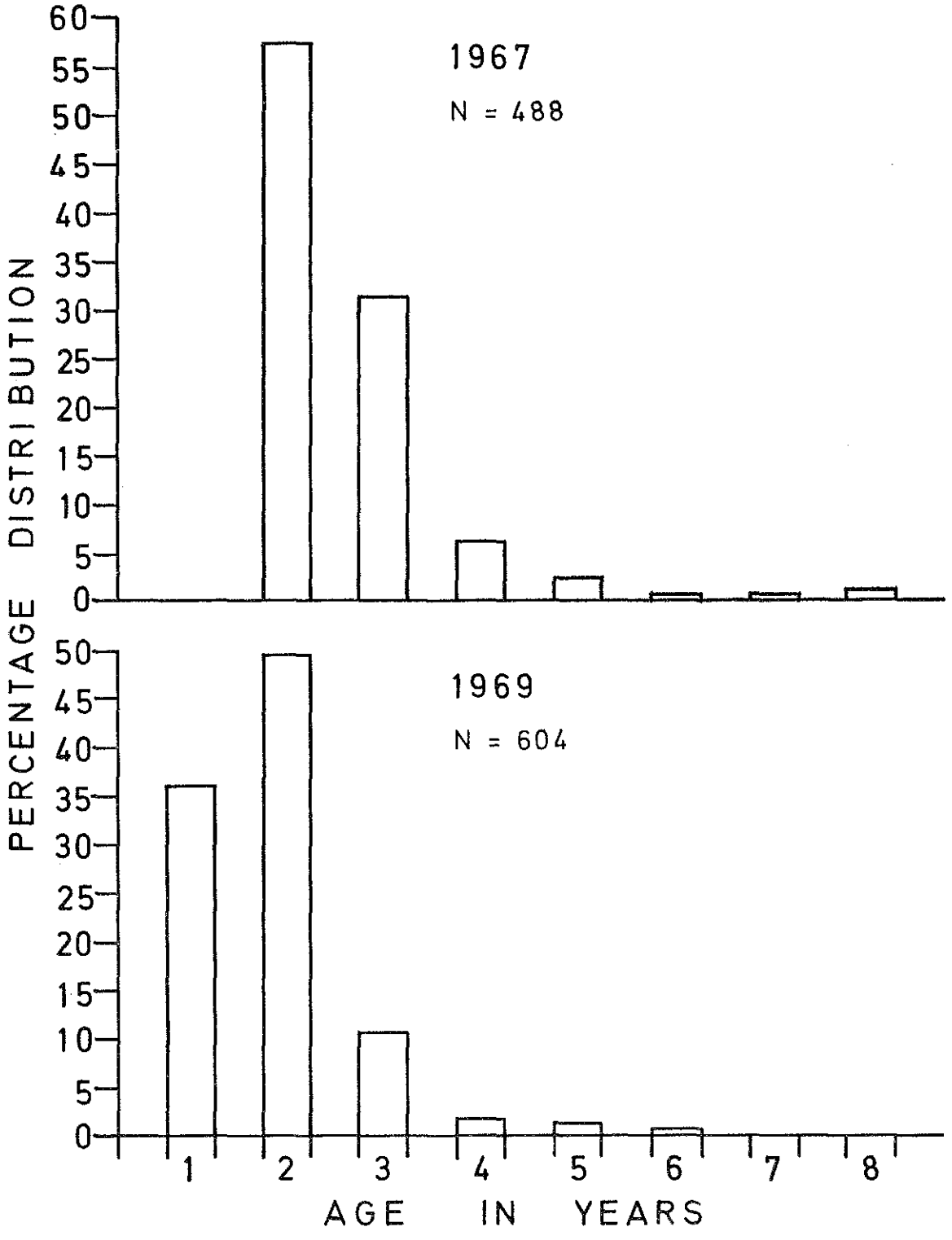

Fig. 4. Percentage age distribution for pike from the Brosna river during 1967 and 1969.

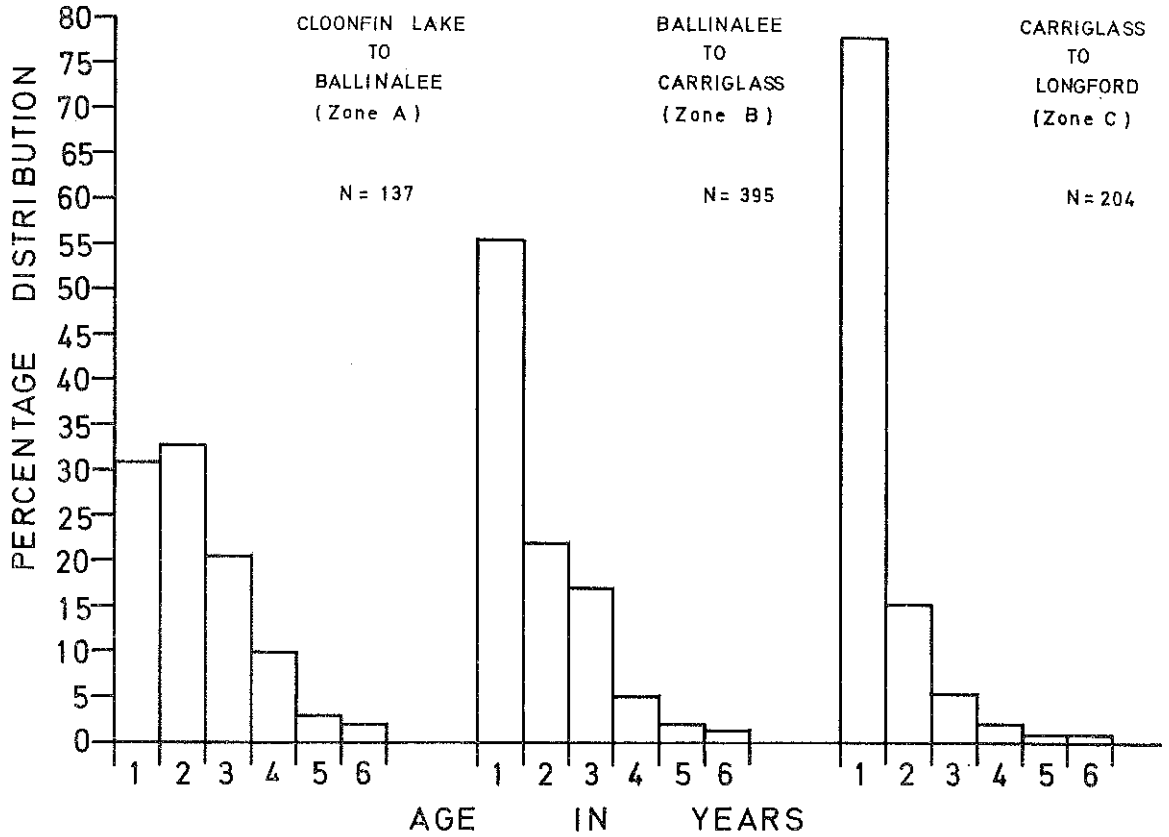

Fig. 5. Percentage age distributions of pike taken in three zones in the Camlin river during 1969.

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